

PI: Robert Harris

CFD Research Corporation - Huntsville, AL

Identification and Significance of Innovation

- * Launch vehicles experience extreme acoustic loads during liftoff driven by the interaction of rocket plumes and plume-generated acoustic waves with ground structures.
- * Higher fidelity liftoff acoustic analysis tools, to design mitigation measures such as deluge water and launch pad geometry, are critically needed to optimize launch pad designs for SLS and commercial launch vehicles.
- * Currently employed predictive capabilities to model the complex turbulent plume physics are too dissipative to accurately resolve the propagation of acoustic waves throughout the launch environment.
- * This project will deliver a high-fidelity prediction tool that integrates unsteady hybrid RANS/LES CFD with a high-order accurate Discontinuous Galerkin (DG) scheme for non-dissipative acoustic field propagation.
- * An innovative hybrid method will be developed to transmit launch-induced acoustics.

Estimated TRL at beginning and end of contract: (Begin: 2 End: 3)

Technical Objectives and Work Plan

The overall objective is to develop a comprehensive computational fluid dynamics and aeroacoustics (CFD/CAA) simulation system for launch vehicle liftoff environment predictions. The specific objectives of Phase I are to demonstrate the feasibility of integrating the proposed simulation techniques and tools, and development of intelligent and automated interfacing procedures tailored to the complexities of the propulsion system interaction with the launch facilities during lift-off.

The Phase I work plan include the following;

- * Demonstrate and evaluate high-order DG solver suitability for CAA Applications
- * Develop and demonstrate methodology for identification of acoustic generation region
- * Utilize overset process to receive and propagate acoustics in DG solver and demonstrate accuracy for CAA applications
- * Demonstrate capabilities by investigation of relevant SLS liftoff environment acoustics
- * Develop a Phase II technology development, validation, demonstration and commercialization roadmap



Proposed Acoustics Simulation Paradigm

NASA Applications

- * Definition of lift-off environments for new launch vehicle designs
- * Acoustic loading predictions from first principle simulations for specific launch vehicle configurations.
- * Analysis of launch pad and liftoff environment noise suppression techniques
- * Launch vehicle payload and instrument acoustic loads predictions
- * Commercial aircraft airframe and landing gear noise predictions

Non-NASA Applications

- * Launch environments by commercial launch service providers such as ULL, ATK, Boeing, Space-X and Orbital Sciences.
- * Acoustic loads predictions by payload system and sensitive instrument developers, particularly for one-of-a-kind DoD, NRO, and NOAA satellites.
- * Conventional and STOVL aircraft jet acoustics

Firm Contacts Silvia Harvey
CFD Research Corporation
215 Wynn Drive, 5th Floor
Huntsville, AL, 35805-1926
PHONE: (256) 726-4800
FAX: (256) 726-4806